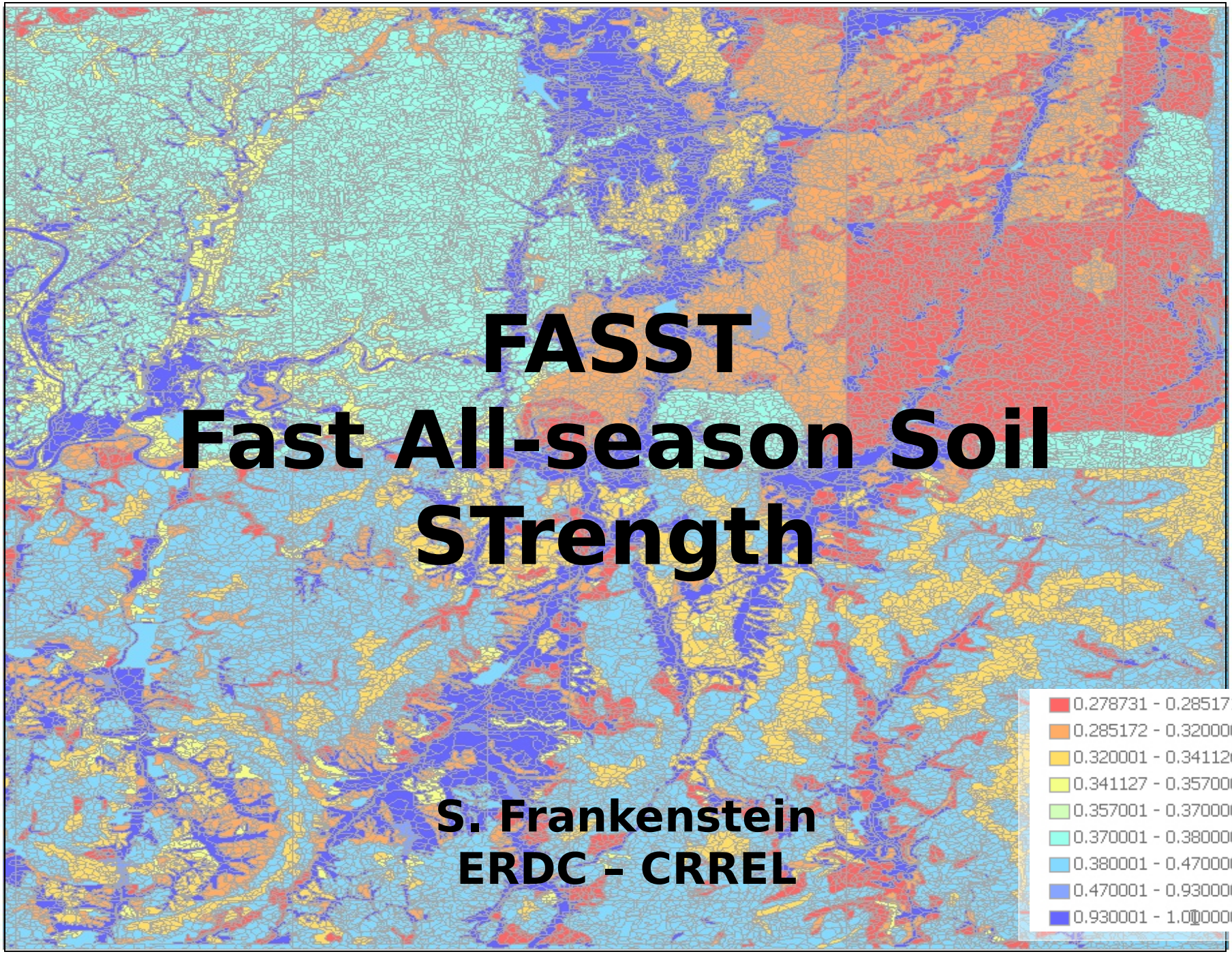
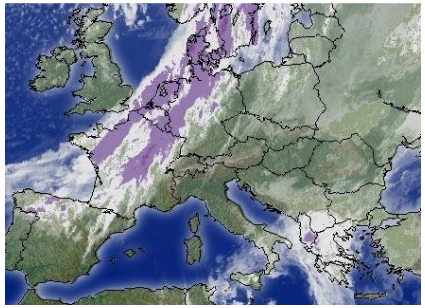
FASST
Fast All-season Soil STrength



S. Frankenstein
ERDC – CRREL

Physics Based Modeling Approach

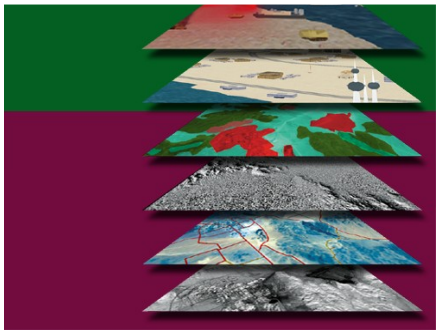
Wx / Atmospheric (Dynamic State)



AFWA – MM5/WRF
Measured – similar to Army & AF battlefield obs

+

Terrain Features

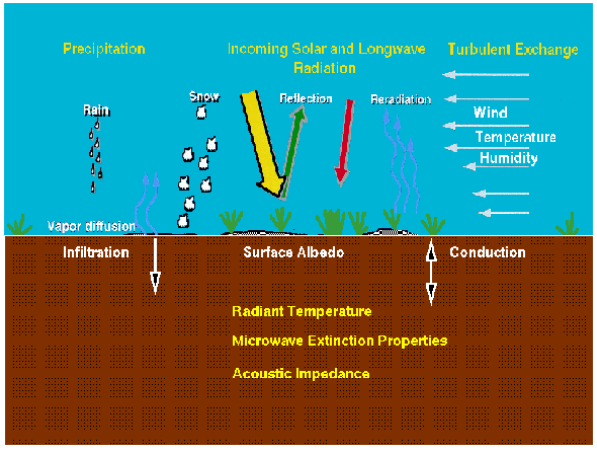


VITD, VMAP, Measured

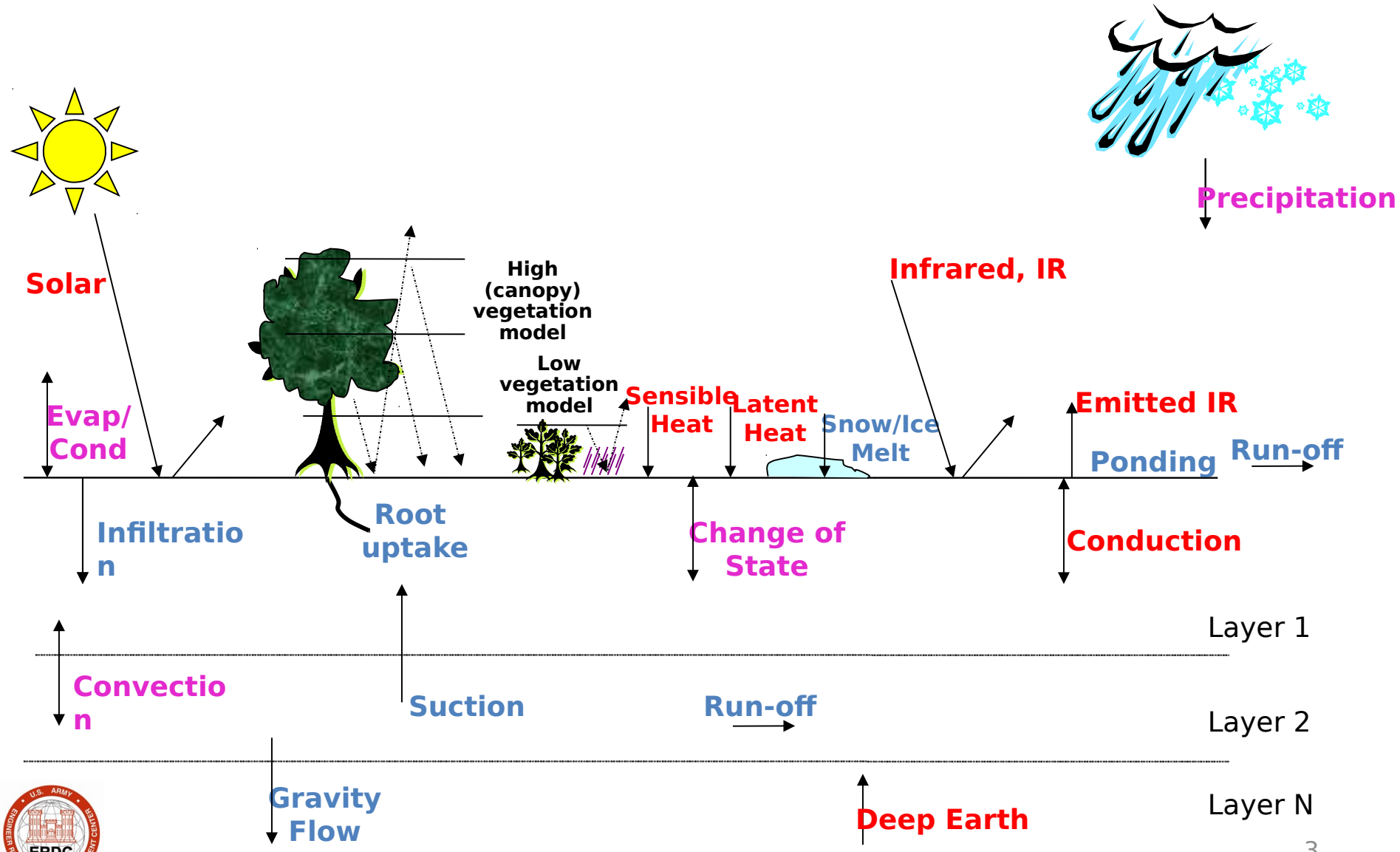
Terrain Complex

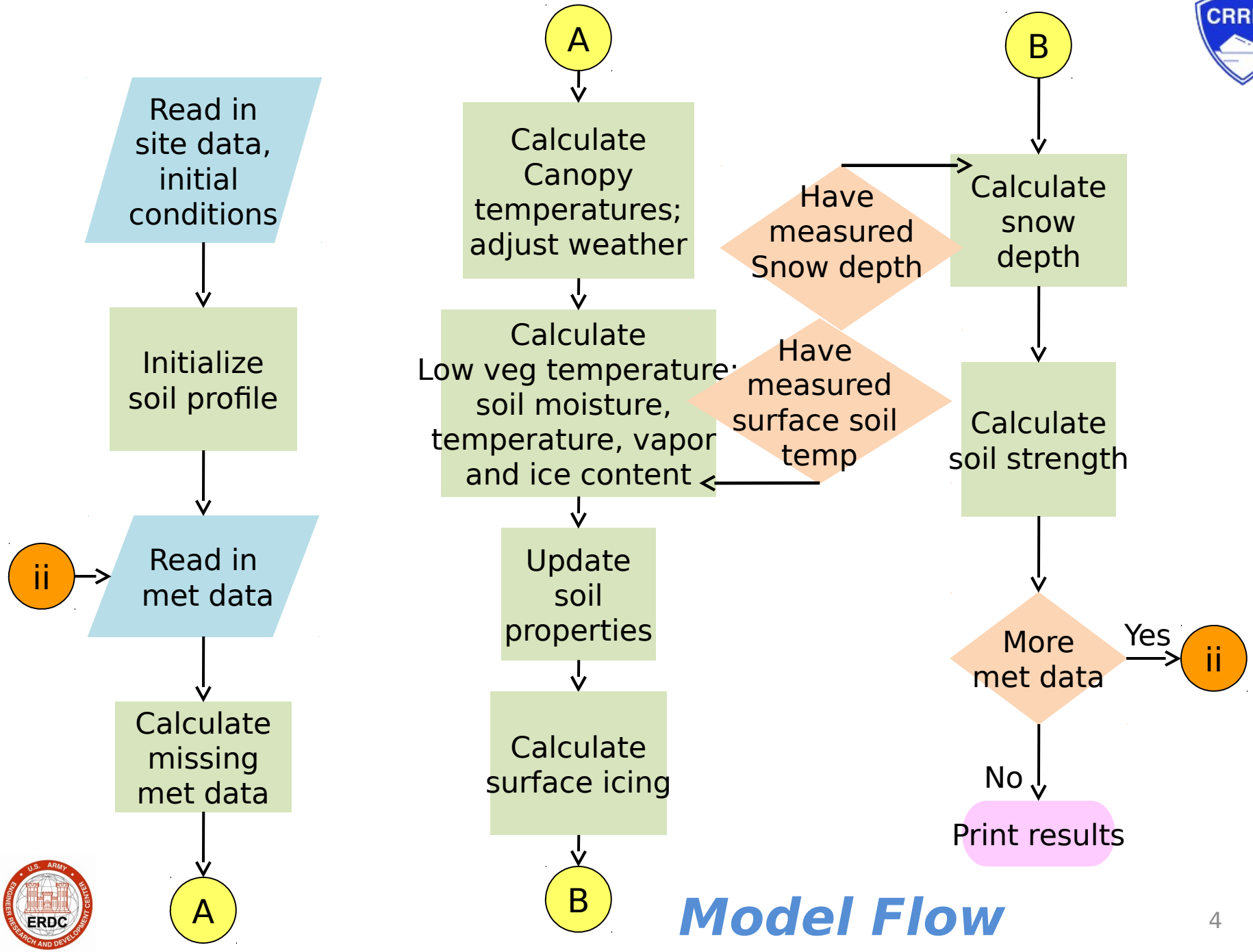
State-of-the-Ground

(FASST – Fast All-season Soil STrength)



FASST Water & Energy Balance




Read in site data, initial conditions
Initialize soil profile
Read in met data
Calculate missing met data
A
ii
A
Calculate Canopy temperatures; adjust weather
Calculate Low veg temperature, soil moisture, temperature, vapor and ice content
Update soil properties
Calculate surface icing
B
B
Have measured Snow depth
Calculate snow depth
Have measured surface soil temp
Calculate soil strength
More met data
Yes
ii
No
Print results

Model Flow

Inputs:

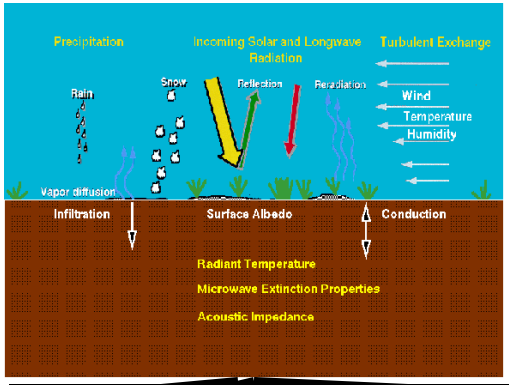
- Meteorological Data (Dynamic)
  - WRF forecast at best resolution (AFWA)
  - Available Weather Observations → AF Combat Wx Team, Army MET upper air, Army tactical obs network
  - Initial Snow Depth & Density, Ice Thickness
- Soil Data (Static)
  - Number of Layers, Layer Thickness & Type
  - Initial Moisture & Temperature Profile
  - Layer material properties (density, porosity,conductivities…)
- Vegetation Data (Static)
  - Type – High and/or Low (classifications based on BATS)
  - Density, Height
- Site Specifics (Static)
  - Latitude, Longitude, Elevation, Slope, Aspect
  - Time offset from GMT

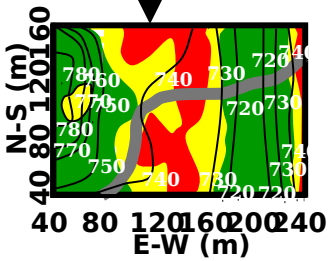
Outputs:

- Soil Temperature
- Soil Moisture – volumetric & gravimetric
- Ice Content
- Vapor Content
- Freeze/Thaw Depth
- Surface State (Frozen/Thawed)
- Snow Depth & Density
- Surface Ice Thickness
- Vegetation Temperatures
- Surface Energy Fluxes
- Mobility specific
  - Surface Slippery Factor (Wet/Dry/Snow/Ice)
  - Soil Strength (CI,RCI and CBR)

Down-stream Feeds and Uses

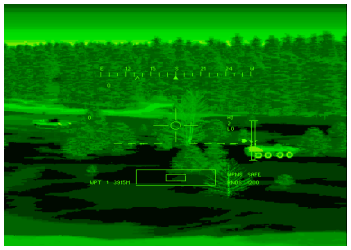
State-of-the-Ground





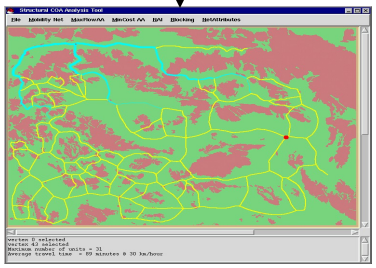
Sensor Performance Product (RSPd, SPEBES)

AER, ARL, C/JMTK, 10th Mountain, BTRA, BTRA-BC



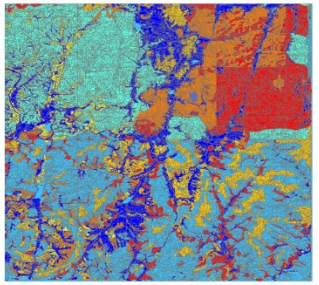
IR Target-Scene Simulation (IRTSS),

USAF Air Maneuver Battle Lab, BTRA-BC, TAWS



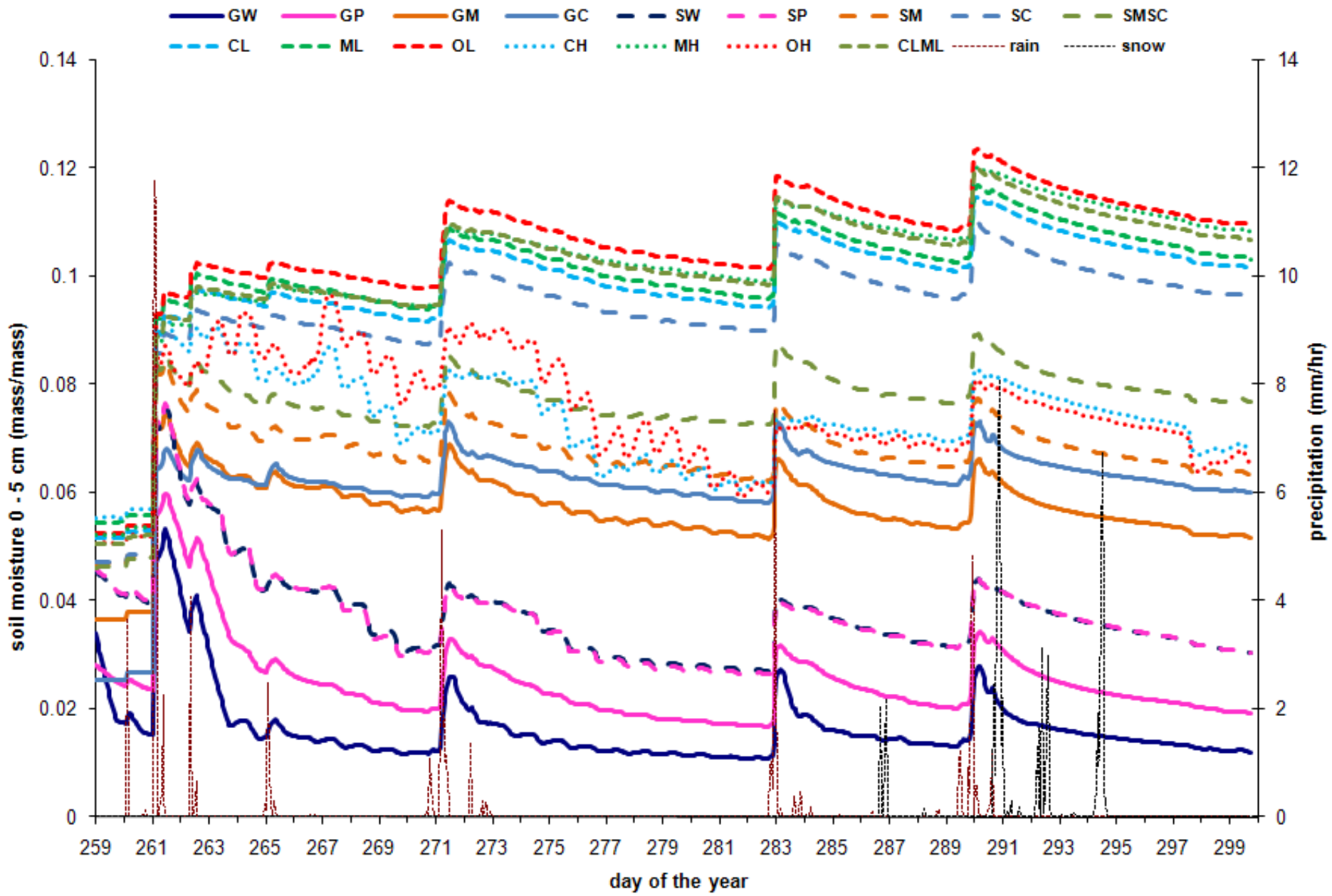
Mobility Planning/ Route Generation (NRMM/STDMOB)

DTSS, DCGS-A, GSL, TEC, BTRA, C/JMTK, State DOT



Dynamic State

NASA, CSU, NPS, SMEX, JRAC, OLS, C/JMTK, CHL, DTSS, NCAR, NOAA, DCGS-A, BTRA, BTRA-BC, JIEDDO, LIS, IWEDA, TAWS


GW
GP
GM
GC
SW
SP
SM
SC
SMSC
CL
ML
OL
CH
MH
OH
CLML
rain
snow
soil moisture 0 - 5 cm (mass/mass)
precipitation (mm/hr)
day of the year
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
14
12
10
8
6
4
2
0
259
261
263
265
267
269
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275
277
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287
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293
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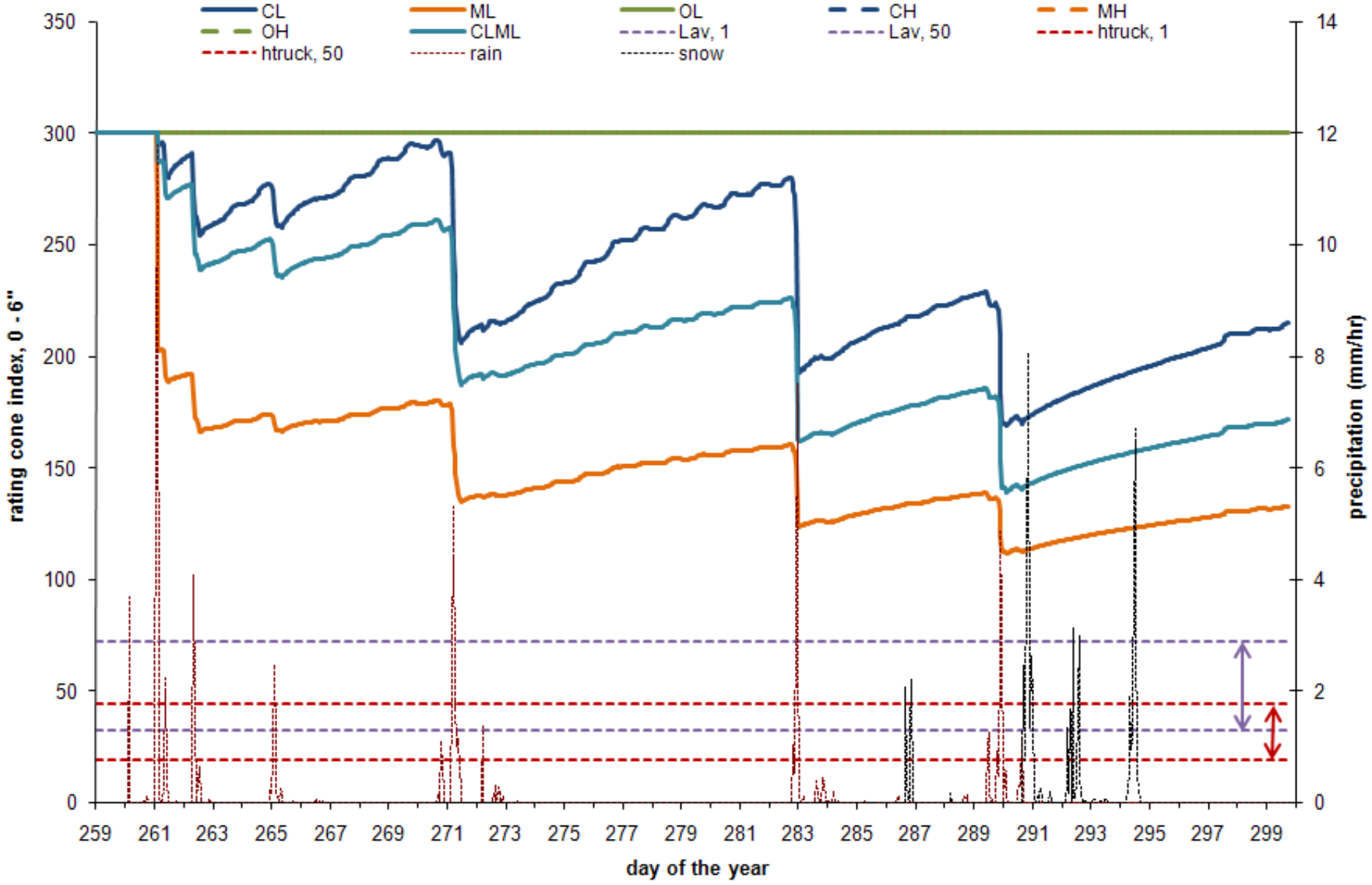
297
299


CL
ML
OL
CH
MH
OH
CLML
Lav, 1
Lav, 50
htruck, 1
htruck, 50
rain
snow
rating cone index, 0 - 6"
precipitation (mm/hr)
day of the year
350
300
250
200
150
100
50
0
14
12
10
8
6
4
2
0
259
261
263
265
267
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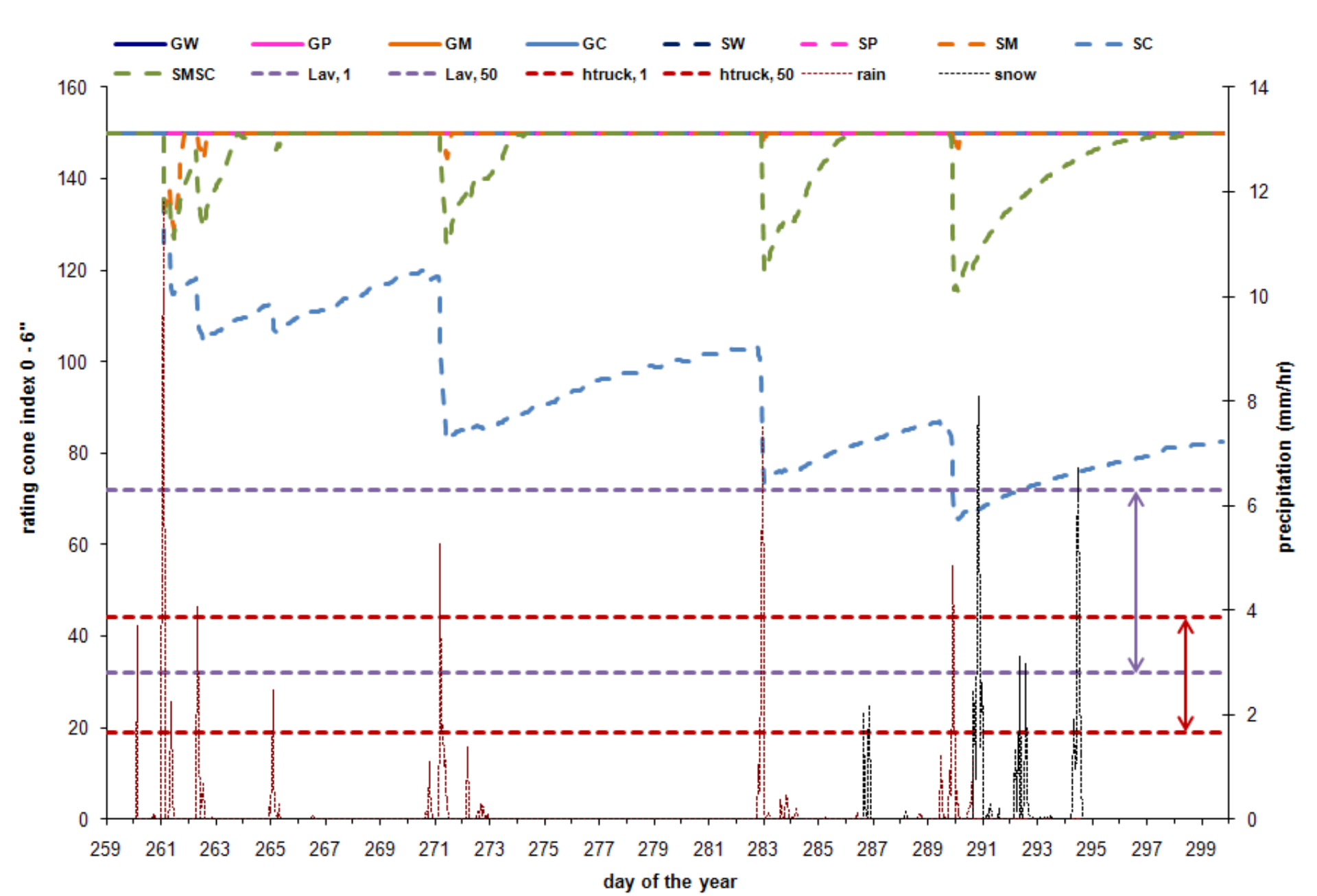
GW
GP
GM
GC
SW
SP
SM
SC
SMSC
Lav, 1
Lav, 50
htruck, 1
htruck, 50
rain
snow
rating cone index 0 - 6"
precipitation (mm/hr)
day of the year
0
20
40
60
80
100
120
140
160
0
2
4
6
8
10
12
14
259
261
263
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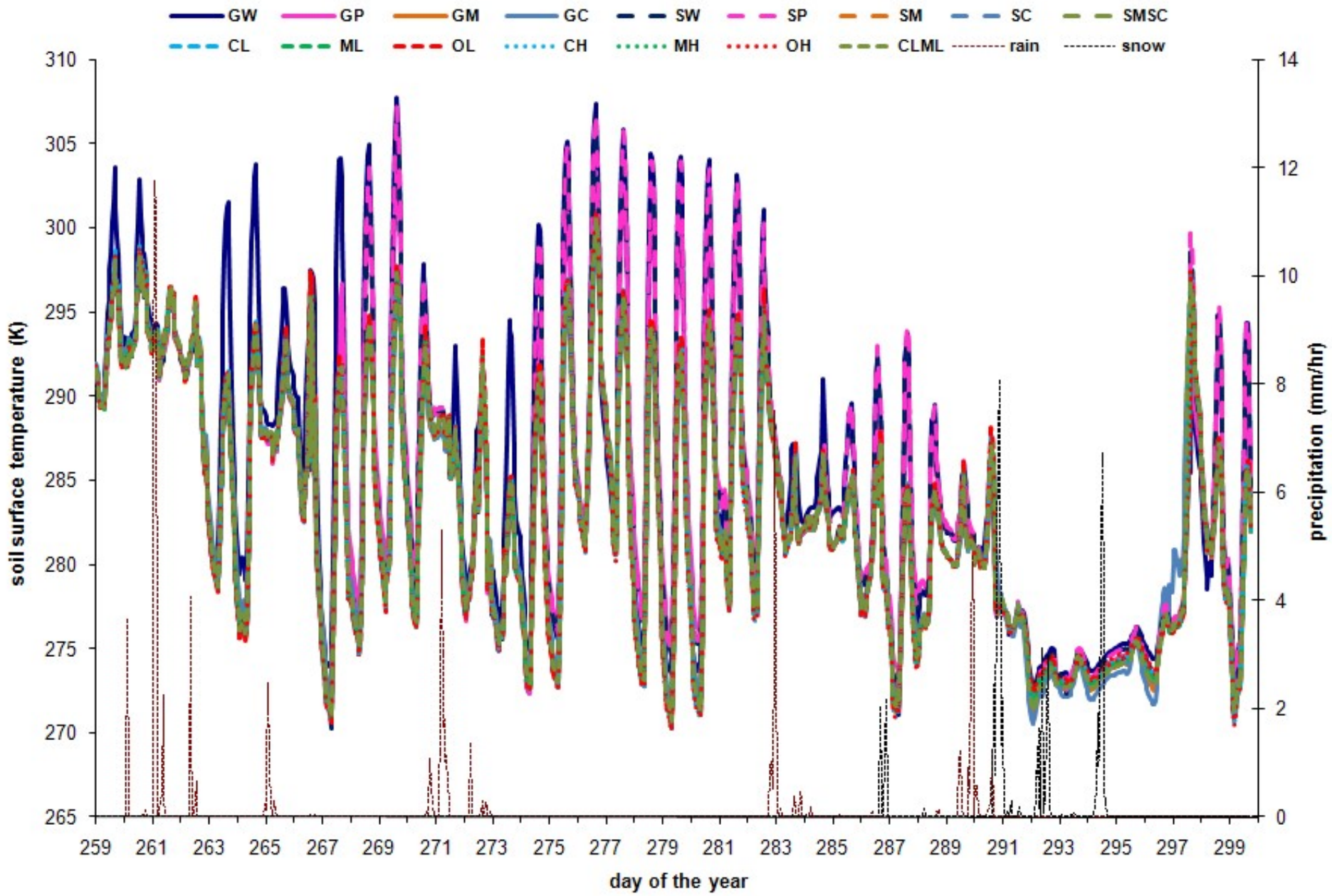
GW
GP
GM
GC
SW
SP
SM
SC
SMSC
CL
ML
OL
CH
MH
OH
CLML
rain
snow
soil surface temperature (K)
precipitation (mm/hr)
day of the year
310
305
300
295
290
285
280
275
270
265
14
12
10
8
6
4
2
0
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263
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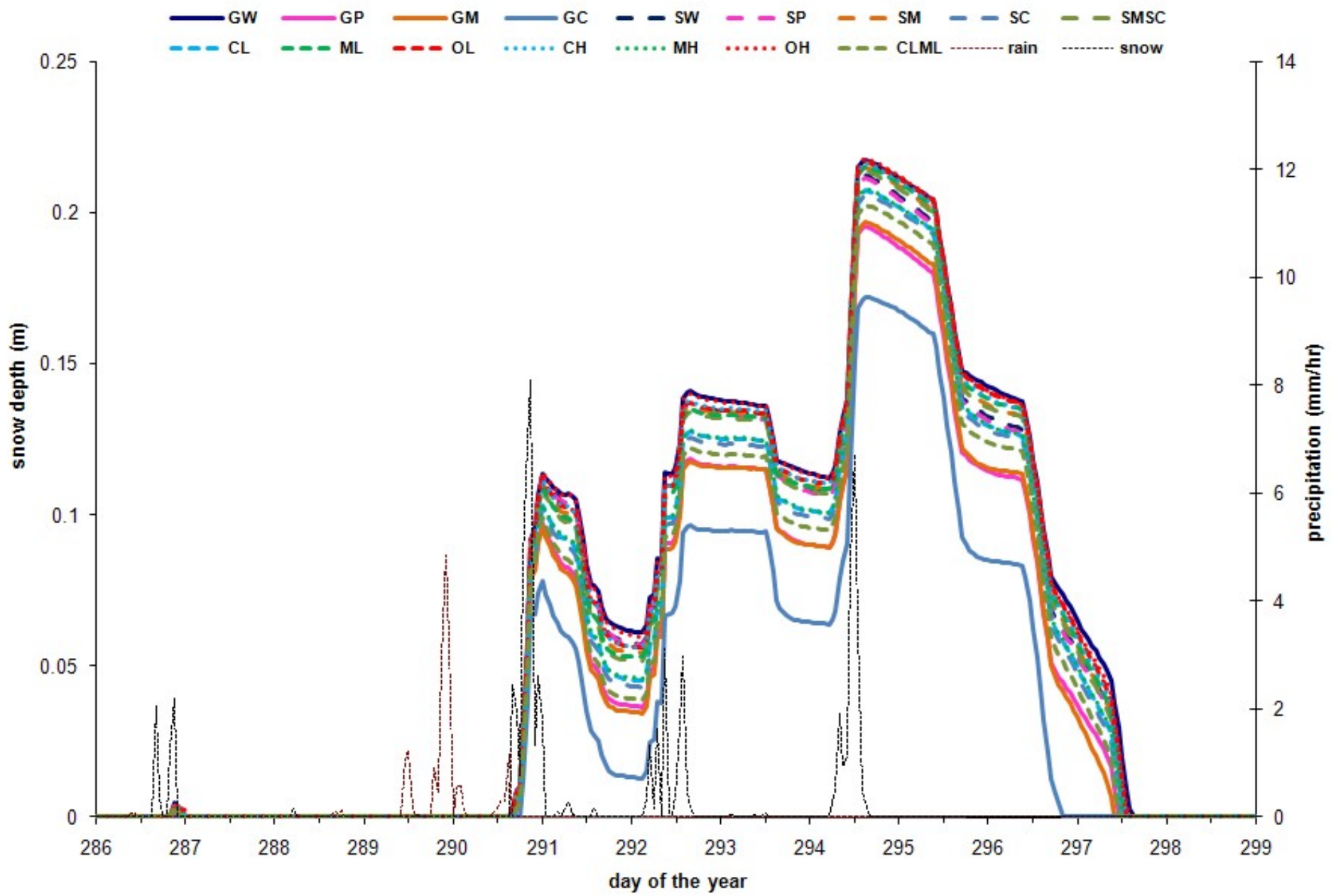
GW
GP
GM
GC
SW
SP
SM
SC
SMSC
CL
ML
OL
CH
MH
OH
CLML
rain
snow
snow depth (m)
precipitation (mm/hr)
day of the year
0.25
0.2
0.15
0.1
0.05
0
14
12
10
8
6
4
2
0
286
287
288
289
290
291
292
293
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296
297
298
299